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Inquiry-based Instruction: How is it Utilized, Accepted, and Assessed in Schools with National Agriscience Teacher Ambassadors?

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The agricultural education profession has established that agriculture can be taught as an integrated science and teachers are receptive to highlighting the science in agriculture. However, there is a lack of consensus and possibly even confusion on the understanding of the term "inquiry" in agricultural education. This study used focus groups to determine the behavior of National Agriscience Teacher Ambassador Academy (NATAA) participants when implementing inquiry-based instruction in their local program. Participants were aware of the term inquiry *but did not have a full understanding of the concept before attending the academy. Teachers also indicated they had to become more prepared ahead of time and that inquiry-based instruction is more rewarding during instruction. Assessment varied greatly based on the local school's expectations of the agriculture department's role and the teacher's connections within their school. Based on these findings, recommendations for the NATAA as well as for future research are included.*

Keywords: inquiry, inquiry-based, national agriscience teacher ambassador academy, qualitative

Introduction/Need for Research

The agricultural education profession has established that agriculture can be taught as an integrated science, and teachers are receptive to highlighting the science in agriculture (Balschweid & Thompson, 2002; Dyer & Osborne, 1999; Johnson & Newman, 1993; Myers, Thoron, & Thompson, 2009; Myers & Washburn, 2008; Thompson, 1998). As agriscience education evolves in the local programs, it is important to remain cognizant of science education reform. Current reform in science education promotes a shift of focus from exclusive pedagogical emphasis on content knowledge to align instruction to inquiry-based instruction. The National Research Council (NRC) publication, *Inquiry and the National Science Education Standards*, stated that inquiry is "something that students do, not something that is done to them" (NRC, 2000, p. 2). Inquiry-based instruction is also characterized by the authentic pursuits of scientists (American Association for the Advancement of Science, 1993; NRC, 1996).

The appeal of inquiry–based teaching for learners and educators is the structure of "knowledge–in–action" rather than "knowledge–out–of–context" (Applebee, 1996, p.30). Advancement in cognitive research and the need to educate all students have led researchers to further evaluate teaching methods (Hinrichsen & Jarrett, 1999). Developing superior ways to teach and amalgamating better ways to engage students should be a goal of every educator (NRC, 2000). Inquiry–based instruction (IBI) contains multiple dimensions of teaching and learning and leads learners to think critically without being critical or concerned with arriving at the correct answer (Keil, Haney, & Zoffel, 2009).

Incorporating authentic inquiry-based activities into the agriscience classroom brings on new roles for learners and teachers. This

change in focus, however, is unknown in agriscience education. The shift in focus has assumed agriscience education has a shared notion of what IBI entails. Furthermore, it has been assumed that individual teachers have adapted a model of what it means to "do inquiry-based agriscience" and are capable of carrying out that model. A widely accepted explanation and definition are provided through five features of the classroom by the NRC (NRC, 2000, p. 25): (a) learners are engaged by questions oriented in science; (b) learners address questions through evidence and evaluation of explanations; (c) learners indicate new explanations that utilize evidence that they create to answer questions; (e) learners consider alternative explanations and evaluate peer learners rationalizations; and (f) learners justify and communicate their selected explanation.

One difficulty in transferring inquiry into practice in education is the lack of understanding involving the term inquiry. According to Merriam-Webster's Collegiate Dictionary (2004, p. 646), "inquiry is an examination into facts or principles, a request for information, and a systematic investigation often of a matter of public interest." Throughout the NRC publication, inquiry is referred to as active student engagement during the learning process (Anderson, 2002). Inquiry is also stated as "a state of mind – that of inquisitiveness" (NRC, 2000, p. xii). Furthermore, the NRC (1996) has recognized inquiry in an educational context and defined it as:

> a multifaceted activity that involved making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. (p. 23)

In agriscience education there remains a paucity of research on how IBI is utilized in the instructional environment to promote student learning. Fradd and Lee (1999) stated that coordination of nontraditional instruction is complex and many teachers have not embraced this mode of teaching and learning which enables students to "think" scientifically. French and Balschweid (2009) conducted a study of agricultural teacher educators and found that only 33% of respondents self-identified that they taught inquiry-based instruction and believed they were "very comfortable" when doing so. The science education community noted aligning instruction and reform efforts appeared slow (Crawford, 2000). The gap between research and practice may contribute to the lack of utilization and understanding in the agriscience profession, leading to little implementation in the classroom.

The meaning of IBI and classroom practice often becomes muddled and the integrity of IBI is lost. At the local level teachers may view their teaching as inquiry-based, yet students do not believe their role as a student and the teacher's role have changed (Roth, Boutonne, McRobbie, & Lucas, 1999). Hawkins (1990) described a loop in history as education expands and develops integration of new teaching and learning techniques. Hawkins stated that integration takes time; with each study the loop expands and then becomes accepted in the profession. Bringing about the next innovation includes finding research–based evidence to deliver the science content within agriculture that is supportive of the national research agenda. Therefore, the need for research to be conducted at the local level to move the profession further into science integration with an inquiry–based focus is vital (Schunk, 2000). Furthermore, agriscience teachers are utilizing IBI and have been trained through the National Agriscience Teacher Ambassador Academy (NATAA). Utilizing NATAA teachers' knowledge to provide mentorship could provide insight into IBI for agriscience education.

Despite the ubiquity of the understanding of the term "inquiry" in agricultural education, little is known how teachers transition to inquiry teaching, conceptualize inquiry in their classroom, and assess student learning through inquiry, and how their IBI is accepted by peer teachers and administrators. Utilizing NATAA teachers who are at the forefront of this expansion of the loop and describing their perceptions of transitioning to a classroom with an inquiry focus may lead the agriscience profession to a stronger definition and execution of authentic inquiry-based learning.

Literature Review

The national survey data by Weiss and Pasley (2004) indicated a lack of focus even after numerous calls were made by the National Research Council to utilize inquiry in the science classroom. Empirical evidence suggested that the reason for the lack of inquiry focus in the classroom is that IBI requires school resources, teachers being engaged in the curriculum, a high knowledge of the curriculum, teacher ability to supply a context, teacher ability to act in a facilitation role and ask guiding questions, and ability to spend adequate time on topics during instruction (Cohen, 1989).

Ball and Cohen (1996) stated that teachers must be prepared in how to implement curricula, be comfortable in understanding their roles as the teacher and role of their learners, and believe in the teaching method. Therefore, curriculum writers must maintain knowledge of the processes of enacting the curriculum and provide professional practice for teachers. Ball and Cohen noted that a gap existed between what curriculum is intended to do and what is enacted by the teacher. Brown and Edelson (2003) conducted a study of three urban middle school science teachers interaction with provided curriculum materials on global warming. Brown and Edelson found that teachers evaluated the constraints of their classroom, devised strategies to utilize the curriculum and meet their instructional goals, and planned to utilize the curricula based on their experience and ability. Based on the teachers evaluation, the teacher then adapted or used the curricular materials in pieces during instruction (Brown & Edelson, 2003). Brown and Edelson described a continuum of full adaption to no adaption of the curriculum. The authors noted that with no formal preparation on curriculum utilization the study provided opportunity, for the curriculum to be underutilized or not utilized for the intended purpose.

Remillard (2005) built on the work of Brown and Edelson (2003) and noted that teachers develop their own curriculum and called for curriculum writers to conceptualize the lessons being taught when they create curricular plans while working with science teachers. Remillard also noted that teachers should always adapt curriculum for their learners, but proper preparation in the teaching method would create effective use of the curriculum (Brown & Edelson, 2003). Remillard found that curriculum where teachers are asked to facilitate students is complex and can foster unanticipated student ideas, the teacher must work through utilizing a good understanding of the curriculum, the teaching method, and the context.

Saunders (1992) conducted a study in science education and stated that steps are needed to organize hands-on, investigative labs. According to Saunders, science education should utilize fewer prescribed methods or procedures to solving problems and exploring phenomena. Saunders described the inquiry approach as an opportunity for students to utilize their own schema and formulate their own expectations that lead to active cognitive involvement. Saunders described inquiry as meaningful learning situations of thinking out loud, developing alternative explanations to problems, interpreting data, presenting and constructively arguing data and the phenomena under investigation, and developing alternative hypotheses and plausible competing explanations.

This study focused on the behavior portion of the theory with the understanding the NATAA participants received education (through the intensive NATAA workshop) that instilled participants with concrete knowledge and modeled instruction. Myers, Thoron, and Thompson (2009) surveyed 25 NATAA participants to assess their level of utilization of IBI. The authors found a majority of the NATAA teacher participants used inquiry strategies two or more times each week. Results also showed that a majority of the NATAA teacher participants asked open-ended questions, allowed for student observations, and scientific thoughts three or more times each week. Myers, et al. also reported that a majority of the NATAA teachers had their students evaluate scientific findings three or more times per week. Myers et al. found 68% of the NATAA indicated their students designed and conducted experiments at least once a week. Further, the study reported NATAA teachers had a favorable attitude toward science integration and IBI in their agricultural education program. The Myers et al. study then reported NATAA teacher attitudes and utilization of IBI leading to a need

to describe how attitudes have governed the behavior.

The next logical step is to investigate NATAA teachers who have received preparation in IBI and can be considered as experts in the agriscience profession when teaching through IBI. NATAA teachers have been prepared through workshop examples and teaching tools to use in their local classroom. Investigation into transition of former teaching methods, reaction from peers and students, and ways to assess this type of learning may provide vital information for future professional development of the profession on IBI and its effectiveness.

Purpose and Objectives

The purpose of this study was to describe NATAA teachers' perceptions of transitioning to and using inquiry-based instruction. The objectives of the research were to describe: (a) NATAA teachers' perceptions of the transition from their former teaching methods into incorporation of IBI; (b) NATAA teachers' perceptions of the reaction by their school environment (students, peer teachers, administration) when they utilized IBI; and (c) NATAA teachers' perceptions of assessment when utilizing IBI.

Methodology

This study used focus groups to determine the perceptions of NATAA participants when implementing IBI in their local program. Focus group discussions are one type of qualitative methodology that creates a process of sharing and comparing among the participants to provide the context and depth behind their thoughts and experiences (Morgan, 1997). They also "provide insight into complicated topics where opinions or attitudes are conditional or where the area of concern relates to multifaceted behavior or motivation" (Krueger, 1994, p. 45).

An emergent design was used to specify the focus of the study and develop the research questions. Under this design, it is inappropriate to specify operational variables or allow theory to dictate the questions for participants (Lincoln & Guba 1985; Patton, 2001). Ten questions were designed by the researchers to gather perceptions regarding teaching with inquiry. A panel of experts familiar with focus group methodology examined the moderator's interview guide for face and content validity. Krueger (1994) stated focus groups have high face validity because the technique is easily understood.

Two focus groups were conducted with 13 participants. The participants were purposively selected based on their participation in the NATAA program, which means they had formal training on IBI. The participant group included a range of male (4) and female (9) teachers with anywhere from two to 16 years of teaching experience. An objective moderator knowledgeable of focus group methodology conducted both sessions; each lasted approximately one hour. The moderator began with a brief explanation of the focus group's purpose and participant introductions to establish a level of comfort in the group (Krueger, 1994) before moving into the questions directly related to the research objectives.

The discussions were videotaped, audio recorded, and transcribed. The transcriptions were analyzed using Glaser's (1978) constant comparative technique in which researchers looked for common themes, similarities, and dissimilarities among the text. Transcripts were coded for themes and categories created. As themes emerged they were compared to existing categories to look for common relationships. New categories were created for distinct themes that did not fit existing categories. To establish credibility, co-authors were provided raw data and the lead researcher's analysis to corroborate findings. Focus group participant feedback was also elicited at the end of each session to confirm the accuracy of the main points. An audit trail containing all data in raw form and clear notes of the analysis was kept for confirmability and dependability. It should be noted that focus groups are conducted to provide in-depth examinations of the topic of interest and are not meant to produce generalizable results (Krueger & Casey, 2000). Readers of the research can determine whether the results may be applied to similar situations, which follows Lincoln and Guba's (1985) standard of transferability.

Results

A summary of the themes that emerged from the data collected through the focus groups is provided. Participants' names have been changed to protect anonymity.

Perceptions of the transition from former teaching methods into inquiry-based instruction

Participants were asked questions regarding their transition from their former teaching methods to the use of inquiry. The major themes discovered in their responses were: (a) the transformation of the teacher's role from the knowledge source to the facilitator and learner, (b) the challenge of inspiring more curiosity in the learners, and (c) greater reward during instruction despite increased planning time required.

In discussing some of the differences the participants noted in transitioning to IBI, they said their roles as teachers changed. Bonnie said, "As the teacher you have to be willing to give up being the center of attention, let the students examine, and develop questions, and encourage them to evaluate their and others methods [of investigation]." Vick said, "You continually catch yourself falling back to the old way of telling and giving answers. It is easier just to tell someone, but more difficult for them to actually learn it." Using inquiry led the teachers to see their task more as a facilitating understanding rather than providing answers. Keri summed this theme:

> The transition is less of a focus on the correct answer and more of a focus on the concept or method under investigation. It is not step-by-step, and that was what we were taught in our teacher ed[ucation] program, so it takes you a totally different route of what everybody else did. [The learners] don't necessarily have to have the correct answer. It's just, can you justify how you got [to the answer].

Participants also spoke of how inquiry requires and leads to more inquisitive learners; however, inspiring that necessary curiosity is a challenging undertaking. Charles observed, "Traditional school kills curiosity. The transition is difficult because, as a teacher, you have to make clear to the students it is OK to ask what difference does this make and what does it mean?" Betty said, "We all kind of give in a little too quickly and want to tell the students how to do a laboratory. Inquiry is also more than hands-on, it is about figuring out the next logical step [for the learner]." Instilling that curiosity requires a different approach than what the participants were used to. Alyssa said, "I used to be scared of the question 'why.'…Now the 'why' starts the activity." Despite the difficulties in making the transition, participants said inquiry methods create a more natural learning process. Bethany commented, "Well it makes so much sense because it's how our brains naturally work." I don't think it is a natural way of teaching, [but] it is definitely a natural way of learning."

The final theme that emerged from the focus group discussions was that the teachers experienced greater reward during instruction despite increased planning time required. Gina said, "IBI is more rewarding and students are actually engaged in their learning."

> Kathy said,
> I think it does take some additional prep time. But I think once you're in the classroom using inquiry totally, you get beat up less. You're not the one presenting all the information and answering every question. And so I feel, at the end of the day, when I've used much more inquiry I'm far more relaxed and I feel like just as much gets accomplished. But I also feel like my students have almost learned more 'cause they've been forced to think about it and stretch their minds a little bit more….I've had to do less of this force feeding them information…..it is much easier on the teacher and it's more fun.

Sadie said, "I found inquiry actually easier to teach, less stressful. However, you have to be prepared and you have to have the material available for student investigation." Kathy and Sadie's comments were characteristic of much of the discussion that followed. Participants suggested for inquiry-based instruction to be rewarding the teacher has to anticipate questions and have ample background knowledge to facilitate student learning.

> Richard said,
> I think [the transition] depends on a certain lesson or unit that I'm in, how prepared am I

> to do this? 'Cause if I don't think about it ahead of time then I just, as a teacher, I get lazy and take the easy way and just give the information because it is easier – you don't have to think about it. Because of being busy with fair and FFA I find it difficult to think ahead and do inquiry for everything, but I want to be a good teacher, and I know my kids like to learn that way.

Perceptions of the reaction from their school environment (students, peer teachers, science teachers, administration)

Overall, the focus group participants said inquiry-based instruction was well-received at their school but had to reassure students who were new to this teaching method. The themes found within this research objective were: (a) the contagiousness of inquiry with other teachers, and (b) students' initial struggle into less structured learning.

Several of the participants said they were placed in a leadership role in their school to help train others on IBI methods. Lynn stated, "Oh my principal loved it! After I got back he wanted to know what I learned and I showed him. Now, I teach the science teachers how to use inquiry."

> Richard said,
> I have to tell you, that I have a teacher at my school that I thought would never change anything she is teaching. She saw how it works in my classroom and now she is borrowing my stuff and asking me how to teach inquiry and is excited about teaching again.

Despite the contagiousness of this teaching method some of the participants experienced, many also noted that their administration is more hands-off when it comes to assessing teaching methods. Keri summed up this theme when she said, "[The administration] doesn't know what I'm doing, but they know it's going on in the science department and it's helping our test scores. So yes, they support it." Sadie said, "My administration does a poor job of observing and keeping up with what I'm doing."

When focus group participants were probed to specifically address their students' reactions, they indicated student enthusiasm rose and they believed their students finally felt comfortable asking thoughtful questions. Vick said, "Most of the students are more motivated and ask great questions and become interested in learning and it is more meaningful." Although participants indicated student enthusiasm improved, the path to get there was a struggle with the transition from high structure to less structure and more independence. Participants noted they utilized IBI two or three times before students broke their motivation of receiving an "A" or the "right answer".

Gina said, "Several of the more concrete learners want and miss the direction the first several times. I started using inquiry and it came time to write up the paper and the students asked for a rubric. I told them they need to present data and draw conclusions. It was a difficult transition."

Keri observed similar reactions from her students but also commented on the positive outcomes.

> They are so focused on the right answer at first, and wonder why [the teacher] is not telling me if I am doing it all wrong. …They adjust and the students that were bored with the old way of teaching are now the ring leaders of the investigations and …the students continually challenge one another's methods.

The moderator asked a follow up question to understand the length of time or amount of inquiry lessons they believed most students needed to fully understand their new environment. Charles answered, "Overall, it took my students about three to four uses of IBI, then they were less skeptical of how they would get their grade and more focused on learning." Richard commented, "I agree with Charles, and to put it into weeks potentially two weeks, maybe three. It [inquiry-based instruction] is a trust thing, they learn to trust the teacher. Once they trust that you are going to allow them to draw conclusions and base their grade on their justification they are excited to be directing the learning." After Charles and Richard's comments, one of the focus groups paused and conversation continued between group members as they created a censuses. The group agreed approximately two to three weeks or utilization of IBI three to four times in the classroom resulted in acceptance and trust of inquiry-based learning by nearly every student.

Perceptions of assessment when utilizing inquiry-based instruction

Due to time constraints, only one of the focus groups had discussion that addressed this research objective. The themes that emerged within this research objective were: (a) assessing students was more process-focused and less outcome-focused, and (b) writing learning objectives for inquiry are difficult. Participants indicated they still assessed students on a paper and pencil "type" test. Some indicated assessing students through a practicum was better-fitting for lessons/units and others indicated assessing students throughout the daily lessons. Overall, the discussion showed that participants preferred assessing the students' process and rationale rather than whether they could memorize and produce the correct outcome. Bethany said, "I assess students based on my goals. That does not always mean a test. Sometimes it is through the presentation of the data and the experimental process and the conclusions they drew from it." Bonnie said, "Assessments should be driven by the curriculum, if my overall goal is to make sure students memorize something then we memorize it, if I want them to learn deeper knowledge I use inquiry and I assess them accordingly." Lynn said, "[With inquiry,] there was no right or wrong answer. I mean there is a correct answer, but I told them as long as they could justify how they came up with that answer, regardless if it was a correct one or not, they got full credit."

Through discussion it became clear the use of objectives for learning was not understood by many of the focus group participants. Alyssa commented,

> Assessments are king at my school, everything is for a test, I survive in that system, I was nervous at first using inquiry because we have to have objectives everyday on the board and I don't know how to write objective without giving the students the answer to the question posed for the day. So I don't give students objectives, but we still take tests like before and the students probably perform better on my exams.

Alyssa's comment struck accord with several participants in the focus group and many indicated through body language and agreeable comments that suggested they struggled with writing objectives that did not give too much direction for the students, others indicated the objectives should be overall learning outcomes and not direct the method in which the student should arrive to achieve successful completion of the objective.

Conclusions/Implications/Recommendations

Based on the themes identified through examination of the data guided by the objectives of this study, the researchers agree upon four conclusions. Directly following each conclusion is a discussion of its implication to the profession and recommendations.

The first objective of the study examined teacher perceptions of the transition in teaching methods. Teachers' perceived inquiry differently after attending the week training provided through NATAA. NATAA teacher participants were aware of the term inquiry but did not have a full understanding of the concept of the roles the teacher and students play during IBI. The second conclusion, transition from former teaching methods, is a process that is different for each teacher. The transition must be created from knowledge and willingness to make the change of teaching through not being or wanting to be the central focus of the classroom. Teachers indicated they had to become more prepared ahead of time but that IBI is more rewarding during the instructional (in class) time with students present. This finding is consistent with Ball and Cohen (1996) who stated as teachers build their knowledge and are aware of their new requirements they must maintain a level of preparedness and expertise. Furthermore, teacher attitudes toward favorable integration of science in the agriscience classroom (Balschweid & Thompson, 2002; Dyer & Osborne, 1999; Johnson & Newman, 1993; Myers et al., 2009; Myers & Washburn, 2008; Thompson, 1998) play a vital role in maintaining focus of correct delivery of the teaching method. Cohen (1989) argued that knowledge of a topic will lead to teachers being engaged in the teaching method.

The implications of this finding is that in order for IBI to be a widely-used teaching and learning philosophy and method of agricultural education programs, an effective preservice program and

professional development program must exist. According to the findings, more experienced teachers have a greater barrier to implementing inquiry into their classroom from the standpoint lessons previously taught still work. Novice teachers are quick to try new methods of teaching; however, misconceptions and misunderstandings will lead to the inability to utilize the method to the full potential and leave the novice teacher unprepared through lack of knowledge of the content under investigation.

The second objective of the study sought to describe the perceptions of the school environment. The principle issue identified was a positive connection between the agriculture teacher and their peers and administrators due to the use of IBI. Positive attitudes for IBI promotes a change in behavior resulting in the agriculture teacher becoming a leader for the school in the new found innovation that can be used in science education. The NRC (1996) called for IBI to be utilized in science education, but as noted earlier, if professional development lacks the innovation will not be utilized. The NATAA participants received the professional development and are now the leading experts in their school, training science teachers. Furthermore, students learning under the use of IBI are more engaged and catch on quickly. However, it was noted that upper-level students transition slower than their peers. The focus group participants recommended a typical student transition of two weeks, or three to four inquiry lessons, before students begin to show acceptance and comfort with IBI. Participants described a classroom learning environment that features nearly all of the NRC's (2000) features of classroom inquiry as they noted students are engaged by questions, and they address those questions through evidence and explanations, challenging each other's rationalizations, and justifying their conclusions.

The implication of this finding is that agriscience teachers can develop an integrated role in their school community and perhaps be seen as an integral part of the school's success on state standardized testing requirements. Teacher education programs should instill a desire for preservice teachers to collaborate with their science teacher peers. Further investigation is recommended to investigate why upper level students are reluctant at first to engage in IBI. Further investigation is needed to determine how to effectively transition all students to IBI. However, it was noted by the researchers many participants acknowledged the students "catch on really quickly." Based on the recommendations from group participants, investigations and future research should be conducted after a two-week student introduction to IBI.

Finally, the third objective explored the ways NATAA teacher participants assessed their students. Confusion by NATAA participants presented mixed perceptions across the teachers. Some teachers found assessing students in the same fashion acceptable; others indicated they assess according to the goal of the instruction, yet still others were concerned with creating an instructional objective to guide assessment. It was indicated by most teachers assessment can remain the same or assessments can be adapted to be better suited for inquiry-based learning. However, some participants indicated assessment is an issue of contention. Crawford (2000) stated reform efforts appeared slow, when a large issue such as assessment is not understood (knowledge) a lack of behavior (teaching inquiry) will lag as described by Brown and Edelson (2003).

One implication of this finding is that the NATAA should address this issue in future programs. Furthermore, the researchers determined preservice and professional development must include not only what inquiry is, how inquiry is taught, how to transition from current methods, but also how assessments may be constructed or why they may remain the same.

Whereas before teachers participated in the NATAA they did not have a good understanding of IBI, the profession needs to create a model for IBI in agricultural education. However, teachers trained in IBI maintain positive perceptions of their teaching and school environment. A quantitative study should be conducted to investigate the effectiveness of IBI in the agriscience classroom. Furthermore, assessments must be examined to determine effective IBI assessments.

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